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NOTES FROM PACIFIC COAST OBSERVATORIES.

CONCERNING SOME FORCES[1] AFFECTING COSMICAL MOTIONS.

It is well known that many cases of discrepancies have existed between the observed positions of bodies in the solar system and their positions as predicted upon the basis of NEWTON'S law of gravitation. Some of the discrepancies have been explained and removed, whereas others still exist.

Halley's Comet returned to perihelion in March, 1759, several months later than the predicted time. It was not until the discoveries of *Uranus* and *Neptune* in 1783 and 1846, respectively, that astronomers were able to explain the discrepancy by virtue of the attractions due to these two planets.

Discrepancies in the motion of *Uranus* led to the discovery of the disturbing body *Neptune* in 1846—facts familiar to all students of astronomical history.

It has long been known that there are minute discrepancies between the observed and predicted motions of *Mercury*, *Venus*, the Earth, and *Mars*. NEWCOMB'S interest in this problem led him to investigate the effects of undiscovered small planets situated between the Sun and the orbit of *Mercury*, or between the orbits of *Mercury* and *Venus*, and likewise of the finely divided matter responsible for the zodiacal light; but he concluded that forces due to such masses could not be the causes of the discrepancies. SEELIGER'S researches, on the contrary, have convinced him and others that the zodiacal-light material may be an extremely important factor in this problem; though, perhaps, this is not the only factor.

The most noteworthy case of discrepancy relates to our Moon, principally because the relative nearness of the Moon to the observer causes the discordances to have considerable angular magnitude; and these remain unexplained.

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[1] In this brief note there has been no effort made for completeness, by including eruptive, gas action, convection, and other minor forces; nor by referring to the important investigations of Leverrier and others.—W. W. C.

It is scarcely an exaggeration to say that successive generations of astronomers fully expected that NEWTON'S law would ultimately be found to explain all such discrepancies, either through more perfect methods in the application of the law or through the action of disturbing bodies as yet undiscovered. The recent discoveries of forces and principles possessing quite different natures from those of gravitation have tended to weaken the view that NEWTON'S law is all-sufficient.

Radiation pressure, discovered theoretically by MAXWELL and established experimentally by LEBEDEW and by NICHOLS and HULL, is far reaching in its consequences upon the cosmical motions of minute particles. In the case of comets' tails, for instance, radiation pressure seems to be more effective than gravitation; but this force appears to be negligible, at least for the present, when we are dealing with relatively large individual masses.

BROWN has investigated the possible effects of the Earth's magnetic force upon the motion of the Moon, only to conclude that this force is ineffective and negligible.

WACHER, LORENTZ, and DE SITTER have discussed the principle of relativity as a possible important factor in explaining existing residuals in the motions of planetary perihelia.

BOTTLINGER and DE SITTER have recently investigated the hypothesis that the mutual gravitational attractions of two bodies may be influenced by the passing of a third body between the first two; the intervening body absorbing, in effect, a certain amount of the original attractive force in accordance with laws depending upon the mass penetrated by the lines of force. There is some evidence that this hypothesis is an approximation to a fact of nature.

HALE'S recent work has led him to the conclusion that the Sun is a weak magnet whose north pole is in a general way situated near the north geographic pole of the Sun. That the Earth and Sun, perhaps the only bodies available for such studies by means of existing resources, should prove to be magnets, of like polarity, argues strongly for the existence of magnetic forces in all other rotating cosmical bodies.

The effects of solar and terrestrial magnetism upon the motions of the Sun and Earth are no doubt negligible for the present, but may it not be that similar forces under other cosmical conditions are highly effective? Consider the case of a close spectroscopic binary system, whose period of revolution is only a few hours or only a few days. We have very strong reasons for believing that the two massive components are rotating on axes essentially parallel, in the same direction with reference to their surroundings, once in each revolution period. If the rotation of a sun or a planet is an important factor in developing its magnetic field, may not the two rapidly-rotating components of the double-star system be magnets of great strength? Is it not probable, further, that they are of like polarity, since they are rotating in the same direction? Further, as the two bodies are separated by a minute distance, may not their magnetic forces, presumably repellant, be effective in causing their orbits to grow larger. DARWIN, POINCARÉ, and SEE have contributed to the widely accepted theory that a stellar mass rotating ever more rapidly to keep pace with decreasing diameter as a result of heat loss, may divide into two components, which continue to revolve around their center of mass in orbits growing larger and larger by virtue of tidal interactions, all operating according to NEWTON's law and the laws of friction. More recent investigators have questioned the sufficiency of tidal interactions to account for the apparent separation of the two components of a double star beyond certain limits. Might it not be well to make quantitative study of repellant magnetic forces in double-star formation and development, based upon hypothetical cases in harmony with existing knowledge concerning spectroscopic and visual double-star systems.

W. W. CAMPBELL.

May 1, 1913.

RECENT CHANGES IN LICK OBSERVATORY APPOINTMENTS.

Dr. JOSEPH H. MOORE, Acting Astronomer in the Lick Observatory, who is in charge of the D. O. Mills Expedition to the southern hemisphere at Santiago, Chile, will return to Mount Hamilton as Assistant Astronomer late in the summer